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Dye laser from optical whiteners

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Abstract. Two optical whiteners have been observed to lase when pumped by a nitrogen laser. These whiteners are marketed under the trade names 'Ranipal' and 'Ranipal-S'. Absorption, fluorescence and stimulated emission spectra of these two chemicals have been recorded. It has been found that the lasing spectral range is nearly identical for the two chemicals with a peak around 432 nm though their absorption and fluorescence spectra are different. 'Ranipal-S' has been found to be a superior lasing chemical with its laser intensity an order of magnitude greater than that of Ranipal.

1. Introduction

Due to extensive use of dye lasers in research and technology the search for new lasing molecules continues. One method of finding them is from the study of their structure (Drexhage 1973, Pavlopoulos 1973) and the other is to search on a trial and error basis. We followed the second alternative and discovered the lasing action in two optical whiteners. These whiteners are marketed by Suhrid Geigy Ltd., Baroda, under the trade names 'Ranipal' and 'Ranipal-S' with the recommendation from their manufacturers that these chemicals are to be used for whitening cotton and synthetic fabrics respectively. The chemical details are not known to us.

In this paper we describe some qualitative measurements on these whiteners.

2. Experiment

The experimental set up of the dye laser system is schematically shown in figure 1. (Myer *et al* 1970). The dye cell was one inch long and was made of an alluminium square tube with $\frac{1}{2}'' \times \frac{1}{2}''$ cross-section. In order to avoid feedback from the cell windows the two ends of the cell were cut at a wedge angle of about 10° with respect to the axis of the tube and microscope slides were epoxied on to them. On the pumping side a rectangular hole was cut and a quartz plate was fixed from inside to keep the dye laser beam away from the edges of the cell windows and thereby avoiding diffraction effects. The dye was pumped by a home built nitrogen laser (Itagi *et al* 1980) whose peak power was about 200 KW at 20 Hz pulse repetition rate. The pump laser beam (cross section : 15 mm × 5 mm)

is focussed to a line into the dye cell by a fused silica cylindrical lens. While focussing care was taken to avoid super fluorescence (i.e., amplified spontaneous emission). The laser cavity was formed by a dielectric coated broad band total reflector of 5 cm radius of curvature at one end and an uncoated fused silica flat as an output coupler at the other end.

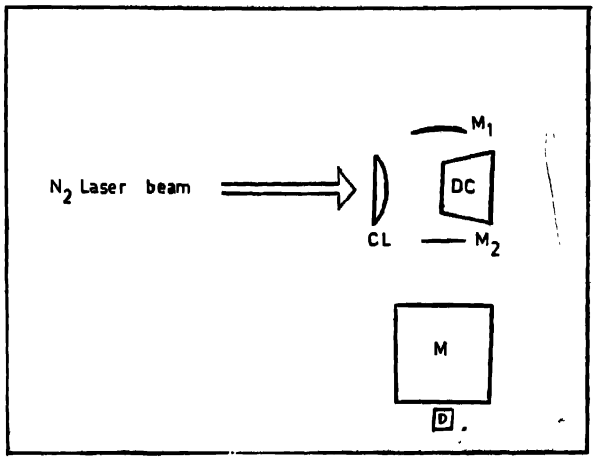

Figure 1. Block diagram of dye laser setup.
CL-Cylindrical lens, M_1-Fully reflecting mirror, M_2-Uncoated fused silica flat, DC-Dye cell, M-Monochromator, D-Detector head.

The dye solutions were prepared by dissolving 500 mg of 'Ranipal' in 55 cc of distilled water and 500 mg of 'Ranipal-S' in 90 cc of methanol. The soutions were filtered before use. It may be noted that 96% of Ranipal (by weight) dissolves in water and 22·5% of 'Ranipal-S' (by weight) dissolves in methanol.

The optical detection system consisted of a grating monochromator (Carl Zeiss SPM 2, 1300 groves/mm) and a calibrated laser power meter (EG and G model-460). The monochromator was kept 5 mtrs away from the dye laser.

The absorption spectra were recorded by a Spectrophotometer (Gilford, model 250). The fluorescence spectra were obtained from a separate set up which consisted of a high pressure quartz mercury arc as a source of excitation, a monochromator as a disperser, a photomultiplier (EMI 9569 QB) as a detector and an electrometer amplifier (ECIL model-EA 810 A) as a recorder.

3. Observations

The absorption and fluorescence spectra and the stimulated emission range of the two whiteners are shown in figures 2 and 3. The absorption and emission intensities have been normalised with respect to their peak intensities. It is seen that both chemicals absorb 337 nm radiation of the nitrogen laser with high efficiency.

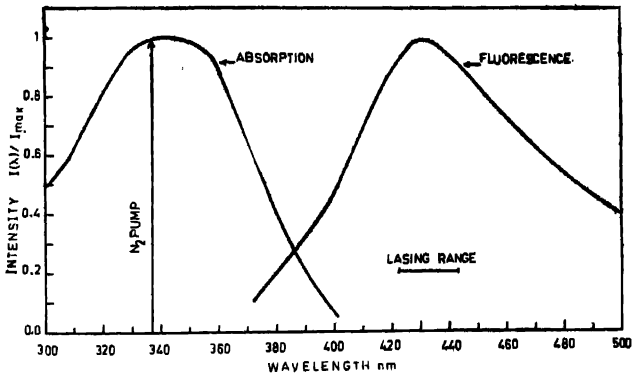

Figure 2. Absorption and fluorescence spectra of 'Ranipal'. Lasing range is shown by heavy line.

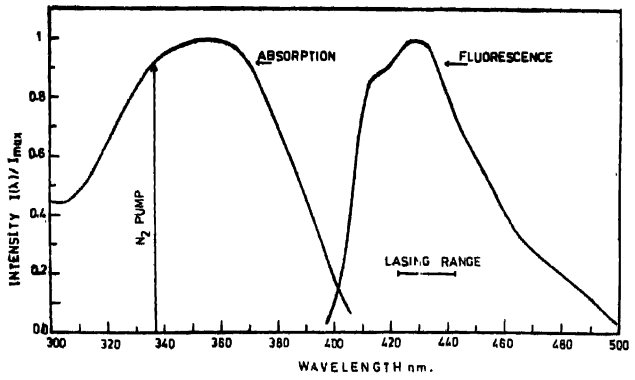

Figure 3. Absorption and fluorescence spectra of 'Ranipal-S'. Lasing range is shown by a heavy line.

Laser action was confirmed when a pump threshold was reached such that an intense collimated laser beam was visually observed. The pump power per unit volume inside the laser medium could be easily varied by changing the distance of the cylindrical lens from the dye cell The other tests that confirmed the lasing are the stoppage of lasing when cavity Q was spoiled and the narrowing of the spectral range of the laser beam (see Figures 2 and 3).

The fluorescence band width of Ranipal-S is smaller than that for Ranipal and hence Ranipal-S is a more efficient laser chemical. In fact, it was experimentally observed that the laser intensity of 'Ranipal-S' was an order of magnitude greater than that of Ranipal.

It was noticed that the 'Ranipal' solution became turbid with passiage of time even in the absence of exposure to pump laser radiation whereas Ranipal-S solution remained clear after long hours of exposure to pump radiation without any decrease in lasing efficiency.

4. Conclusions

In conclusion it may be asserted that a very efficient, inexpensive and readily available lasing chemical in the form of Ranipal-S has been discovered The laser intensity of this chemical, in its own spectral range, is comparable with that of Rhodamine 6G

The studies on gain as a function of wavelength and concentration effect on lasing of 'Ranipal-S' have also been carried out and these will form a separate publication.

Acknowledgment

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